

8/17/87.

Proposal for a publication by the American Academy of Arts and Sciences on:

The Genetic Revolution and the Public

Bernard D. Davis

Background

The American Academy of Arts and Sciences has sponsored several interdisciplinary publications on the interactions of science and the public. These include an issue of *Daedalus* (Summer, 1974), organized by Gerald Holton, on "Science and Its Public: the Changing Relationship;" another (Spring 1978), organized by G. Holton and R. Morison, on "Limits of Scientific Inquiry;" and a volume (Univ. of California Press, 19) on "Progress and Its Discontents." Meanwhile, controversy over the social impacts of science and technology has grown, especially in connection with the dramatic advances in the biomedical sciences made possible by the development of the recombinant DNA methodology. Indeed, in the foreword to a collection of my essays ("Storm Over Biology") Prof. Edward Shils expressed the conviction that we face a growing anti-science movement, and that it is insufficiently recognized because its growth is so gradual and because it is intimately linked to a more positive public interest in science.

Discussion with Prof. Shils and a number of colleagues led to the formation of a steering committee of the Academy, which endorsed the view that a volume on this subject would be timely. The group further recommended that we enfold the topic of the anti-science movement within a broader framework, and that we sharpen the focus of the volume by concentrating on biology, and particularly on the impact of advances in molecular genetics and related aspects of cell biology.

We could also include other areas of advance in the biomedical sciences that are equally of public concern, such as innovations in human reproduction (e.g., surrogate motherhood, embryo research), expensive procedures in medicine, and the far-reaching consequences of changing practices in agriculture. It is not clear whether these would make the volume too large or whether they would better round out a discussion of public apprehensions. These topics are listed here as options. If they are included one might replace "The Genetic Revolution" in the title of the symposium by "The New Biology".

Content

The volume has two main purposes:

1) To distinguish real from excessively conjectural problems, in a number of specific areas in biology; to compare these with parallel problems in the physical sciences and technologies; and to engage in some prediction about probable future developments. We would hope to present a set of definitive and responsible statements on a series of issues that have been the subject of considerable controversy.

2) To dissect the factors that contribute to public apprehension in this area, as a paradigm for concern about all science and technology. This part of the project is the most novel, since there are numerous other symposia on the technical aspects of genetic engineering. It is also the most important (as well as the most difficult). The American Academy is in a particularly good position to select authors and reviewers who could consider these problems within a broad philosophical and social framework.

The Audience

The discussion of the social and philosophical aspects of the subject will overlap with parts of the earlier volume on "Progress and Its Discontents." However, that book received less attention than it deserved -- perhaps because it was rather long, and its focus and title were too abstract to arouse much interest outside circles of philosophers and historians. The proposed volume should interest a wider audience, since it would present a briefer exposition of these problems and would link them with concrete issues in biology that are prominent in the daily news. Indeed, we would hope not only to dissect the issues for a scholarly audience but also to have some impact on a broader public -- high school science teachers might be the benchmark. The papers should therefore be written with this goal in mind. Moreover, because it will probably require about two years to complete the project, it is important that the discussion of topical problems be presented in a framework that will retain interest after they have dropped out of the news, and will hopefully improve the response to similar future problems.

We would plan to publish this collection of essays as an issue of *Daedalus*, which would assure a broad scholarly audience. In addition, because of our broader aim, it would be important to plan to present the same material also as a book. The Academy has occasionally sponsored such double publication in the past on issues of sufficiently broad interest -- for example, arms control.

Prof. Shils, strongly convinced of the need for a long-term defense against the anti-science movement, has further urged that we plan for a continuing series of short books, which would have a more prolonged impact than any single volume. If the proposed volume is successful it could serve as the springboard for such a series.

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Suggested topics and authors for Amer. Acad. volume.

[The outlines are rather detailed, to provide a basis for judging the relevance of the topic and to invite further suggestions; the authors who are finally selected will no doubt deviate a good deal from these outlines. Suggestions of alternatives to the proposed authors are also welcome.]

The Genetic Revolution and the Public

1. Introduction

B. D. Davis

In describing the purpose of this volume, this piece would first provide a brief perspective on the development of the fields of microbial and molecular genetics, and on the reasons that their practical applications were delayed so long, until the recombinant DNA methodology. It would then survey briefly the history of the widespread public anxiety in the 1970s over these applications. In addition, since molecular genetics also offers fresh and growing insights into aspects of human biology that have long generated public controversy -- our evolutionary origin and our diversity -- it seems appropriate for this volume also to consider these insights, and their inevitable future expansion. Various topics in this essay might be handled either very briefly or at greater length, depending on how they are covered in the following papers. This introduction might also summarize briefly the content of these papers; but if it is to lay down the historical background this summary might better be a separate foreword.

2. Sources of Public Concern

? E. Shils (Chicago)

? J. Lederberg (Rockefeller)

Much of the public concern over biotechnology involves remote, hypothetical dangers, generated by extrapolation from the real dangers or harms created by physical technologies. Another extrapolation leads from our increasing affluence and physical security to an expectation of almost absolute security. A more general problem involves limits: extrapolation from the ability of science to answer questions about nature to the assumption that it can be equally applied to questions involving values; and resulting criticism for the failure of scientists to tackle such urgent problems as the deterioration of our inner cities. This last topic might include a brief discussion of the relations between the social sciences and the natural sciences.

Other concerns, however, have a more realistic foundation: the delayed recognition that the benefits of technology are coupled with large costs, including possible annihilation in nuclear war, exhaustion of resources and increasing pollution, unequal global distribution of improved food production and disease control, and uncontrollable population growth. It is also easy to understand the fear that the application of genetic engineering to humans for therapeutic purposes will inevitably lead to a hubris in which man "plays God;" and similarly, increasing ability to predict health problems may give us more knowledge about our futures than we can comfortably handle. In still another, more abstract area of concern, scientific insights threaten religious dogmas that have provided both comfort and the traditional foundation for a moral consensus in the West. Recognizing that science has created a real problem by undermining this foundation without supplying an adequate

replacement for most people, the paper might express some sympathy for those who fear that this development will lead to -- and, indeed, has already fostered -- extreme moral relativism.

We might need two papers here, one rebutting false charges of the anti-science movement, and the other on those criticisms of science and technology that merit attention, and on ways of responding to them. In an earlier issue of *Daedalus* T. Roszak played the latter role, but his views were so extreme that I did not find them interesting. Possible candidates: J. Starobinski (Geneva); R. Lifton (Yale).

3. Contributions from the History and Philosophy of Science C. Gillispie (Princeton)

Shifts in the views of many philosophers and historians of science have contributed to a decrease of confidence in the ultimate value and reliability of its products, and this influence is seen in the attitudes of many science writers (see below). This paper would discuss the widespread questioning of the objectivity of science in recent years, including contributions of the externalist interpretation of the history of science, Kuhnian paradigms overemphasizing the tentative and transient nature of all conceptual schemes in science, Marxists moved by their political ideals to try to impose dialectical approaches on biology, and social scientists emphasizing the similarity of their fields to the natural sciences. Further analysis of the problem of objectivity would include discussion of the multiple meanings of "science" (as a methodology, an activity, and a body of knowledge), and the difference between the uncertainties at the growing points (which tend to be emphasized in science reporting) and the reliability of the major body of knowledge. The paper could also include discussion of fraud, especially in the medical sciences, as a major area of current criticism of the scientific community; and this discussion could point out that the scientific community has found it most efficient to eliminate error largely by neglect, rather than by the active purification of the literature demanded by some amateur science "critics." The topic of fraud, however, might be too peripheral.

Since this area is controversial a second point of view might be in order. Candidate: L. Graham.

4. Changing Roles of Science Writers ? S. Rothman (Amherst ?)

The older generation of science writers for newspapers and magazines in general loved and admired science, while many of the younger science writers today mix this attitude with a good deal of suspicion of science (as of all institutions), eagerness to emphasize social and moral implications (where they are more on a level with their subjects), and a tendency to insert critical insights despite the limited depth of their knowledge. The history of how the news media have spread alarm over the hypothetical dangers from recombinant bacteria, including excessive attention in recent years to the pronouncements of Jeremy Rifkin, could illustrate the problem. Some of the topics suggested for the immediately preceding essay might better fit here.

Alternatively, this topic could be approached by focusing entirely on the history of the recombinant DNA controversy, ending with a discussion of the problems faced by the news media in handling controversies over highly technical issues, and the problem the scientific community faces in trying to educate the public on such issues. A "dark-horse" candidate for this paper would be Ullica Segerstrale, a young sociologist of science (now in Finland), whose thesis at Harvard, on the Wilson-Lewontin controversy, has become a brilliant paper (*Biol. and Philos.*, Vol. 1, No. 1) and a forthcoming book.

? Comment by a science writer or a teacher in the growing number of courses for science journalists. ?Victor McElhenny (MIT).

5. Public Presentation of Science in the Soviet Union S. Kapitsa

This topic was suggested with great enthusiasm by Max Perutz. Kapitsa, the son of the eminent physicist, is an academician whose television programs are a major source of public education on science in the USSR, and Prof. Perutz is confident that after reading the other papers in this volume he could provide a thoughtful comparison with the way issues of science and society are handled in his country. Such a comparison is not central to our theme, but it might be a very interesting addition, which would not be likely to find another appropriate place for publication. Kapitsa apparently visits the USA from time to time and might be able to meet with the group of authors when they go over each other's drafts.

6. Applications to Humans

A. Motulsky (U. Washington);
B. Muller-Hill (Koln)

The two proposed authors and I will be the speakers on social aspects of genetic engineering at a symposium at the International Congress of Genetics next year. Either of them would do a fine job of summarizing what kinds of gene therapy are possible or likely, in somatic cells or in the germ line, and what scenarios under current discussion are excessively remote. Muller-Hill, who spent some years at Harvard, has the advantage that he can combine a defense of desirable forms of therapy with a sensitive discussion of the distortions of genetics under the Nazis -- a subject on which he has written a book in German. This essay should also discuss an aspect of molecular genetics that has much wider applicability than therapy, and is already at hand and rapidly expanding: tests for defective genes, which provide the option of selective abortion when conducted prenatally.

7. Engineered Bacteria and the Environment

H. Schneiderman (Monsanto);
Maxine Singer (Carnegie Inst.)

Microbes, modified by classical techniques of selection of spontaneous variants, have been used for thousands of years in making bread, wine, and cheese, and more recently in antibiotic manufacture and as microbial pesticides and nitrogen fixers in agriculture. The recombinant DNA technology accelerates and broadens the possibility of such domestication, and there is no reasonable basis for expecting recombinants between non-pathogenic organisms to result inadvertently in disease or other adverse effects. But while this issue was settled some years ago for accidental release of recombinants from the laboratory, it has arisen anew for proposed deliberate introduction, on a larger scale, into the environment -- even though the key factor is ability to compete and spread and to do harm, rather than scale of introduction. An unusual feature of this problem, meriting discussion, is the wide split between microbiologists and ecologists. The result has been excessively restrictive regulations by the EPA in the USA, and a complete ban for 5 years in certain European countries.

This paper might include a review of the earlier controversy, over accidental release from the laboratory, unless it is covered adequately in other papers.

Both the authors suggested here have written excellent papers dispelling wild fears of recombinant organisms; Schneiderman is closer

to the specific problems of bacteria engineered for use in agriculture. Because the subject is controversial a comment by an ecologist who is not excessively alarmist might be useful. ?R. May (Princeton); Jared Diamond (UCLA)

8. Genetic Engineering and Animal Rights

Robert R. Marshak (U. Penn)

The animal rights movement would deserve a symposium of its own. However, a short essay tracing its origins and analyzing its present state would be in order in this volume, as a conspicuous example of the anti-science movement, and one strongly focused today on developments involving genetics (transgenic animals; the patenting of genetically modified animals). In addition, animal testing will be an essential intermediate step in most applications of advances in molecular biology to medicine. Finally, the engineering of agricultural animals promises benefits that deserve more public attention (e.g., development of meat with a low content of the fatty acids that promote atherosclerosis). This topic arose from a discussion with Dr. Marshak (recently retired as Dean of the Veterinary School at U. Penn.), and with his colleague Leon Weiss.

9. Molecular Evidence on Evolution

F. Ayala (Davis, CA)

This paper would touch only briefly on the voluminous literature on the creationist controversy and would emphasize the direct nature of the evidence from comparative biochemistry and from DNA sequences, complementing the traditional but gap-filled fossil record. This evidence also answers the charge that evolutionary biology is not sufficiently predictive to fulfill the requirements of a science: for a correlation between phenotypic divergence and divergence in DNA sequence is a strong prediction. This presentation could be coupled with a recognition of the real problems that underly the objections of religious groups, unless that topic is fully covered in essay #2. Lest the paper seem to be flogging a dead horse, it should summarize evidence for the extraordinarily limited acceptance of evolution in the American public. It might also discuss the reasons for this resistance, and the possible implications for a parallel receptivity to myths in areas of more immediate concern for social and political policy.

10. Biological Insights into Human Diversity

B. D. Davis

The role of genetics in human behavioral differences has been a passionately contested issue within the academic as well as the political community, but not one closely linked to molecular genetics. However, with the rapid growth of molecular studies in neurobiology there can be little doubt that the next decade or two will see the sterile controversies over the heritability of IQ replaced by direct identification of molecular bases for subtle individual differences in behavioral traits, as has already been done for such major defects as phenylketonuria or bipolar (manic-depressive) affective disorders. In addition, the prospect of genetically mapping and then sequencing the entire human genome is drawing close, and it will provide a foundation for precise definition of the genetic basis of differences between individuals in all kinds of traits.

Meanwhile, if the evidence from molecular genetics increases public acceptance of evolution (the preceding topic) it should thereby increase acceptance of a fundamental evolutionary principle: that our species could not have evolved so rapidly in its behavioral traits without a large reservoir of

genetic diversity. The paper could also emphasize a) the need to recognize the evolutionary and social value of that diversity, rather than to try to solve social problems by denying it; b) the role of biology in replacing traditional typological (essentialist) concepts of race by populational concepts (as emphasized by E. Mayr); and c) the contribution of this development to our contemporary rejection of the notion that specific capacities of individuals can be inferred from their membership in an ethnic group.

If this topic seems too far from the central theme of the volume the last part could be dropped.

?Comment:

E. Mayr

11. Role of the Courts

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The field testing of ice-minus bacteria, as agents to inhibit frost damage of crops, was approved by the Recombinant DNA Advisory Committee of the National Institutes of Health four years ago, because there were exceptionally strong scientific grounds for considering the strain safe. However, the tests were delayed until this year by legal actions of Mr. Jeremy Rifkin and by bureaucratic regulations. They have now been conducted, with no harm except unwarranted public apprehension, a waste of money, and delay in developing a potentially valuable product. The initial court granted Mr. Rifkin's suit on the grounds that it could not judge the scientific issue, but since there were scientists testifying on both sides the plaintiffs had a plausible case. The appeals court ruled that while there was no serious basis for inferring danger the NIH Committee had no written record to show that it had taken a sufficiently "hard look" at the novel issue of deliberate release of bacteria to the environment. These judgments raise questions about the suitability of our present legal procedures for handling highly technical issues of this kind, and so an analysis by a legal expert, including discussion of previous suggestions of "science courts," might be an interesting addition to the volume.

?Comment

Kantrowitz (Dartmouth)

Optional Additional Topics

12. Genetic Engineering and Our Food Supply ?Jean Mayer (Tufts)

The applications of genetic engineering to livestock and to plants will surely result in large innovations, including the possibility of using higher plants to produce valuable proteins more cheaply than microbes, changing the composition of meat and crops, and adapting crop plants to growth on previously unproductive land. There is controversy at present over the use of hormones (administered or in transgenic animals) to increase meat or milk production, and over the pollution arising from the heavy fertilization of crops engineered for a high nitrogen demand; but these topics are not major sources of criticism of genetic engineering.

13. Changing Expectations of Medicine A. Relman (NEJ Med.)

The public tends to extrapolate from the striking advances in medicine to the expectation of perfection in the control of disease. A discussion of this problem would parallel a theme found in several of the preceding essays: that failure to recognize limits gives rise to misconceptions and illusions. This essay could also provide balance by reminding us that some of the most impressive advances (e.g., in the treatment of coronary thrombosis) have been in the area of physiology and not molecular biology. Without going into detail on the problem of the changing economics of medical care, the article could also touch on the problems created by the ability of advances in biology to lead to ever more expensive applications to medicine, and also the problems created by the shifting age distribution of the population. This article would thus include prime examples of both real and imaginary problems associated with scientific advances.

14. Neurosciences and Psychiatry S. Snyder (Johns Hopkins)

Rapid advances in neurobiology and neuropharmacology have resulted in increasing insight into biological aspects of human behavior, including the identification of neurohormones and receptors that promise to revolutionize the design of drugs and the analysis of function. Meanwhile, the use of the available drugs has been replacing verbal therapy in the treatment of a variety of behavioral problems and symptoms. At the same time, serious problems have been created by large-scale deinstitutionalization of patients who cannot take care of themselves.

This paper is not very closely connected with the central theme. However, it provides an example of how lack of wisdom in the applications of a scientific advance have created a problem. The paper also may overlap with the one on human diversity, but it could further consider the promise of increasing insights into biological aspects of criminal behavior, as an area where public interpretations are likely to involve either excessive expectations or resistance on moral or ideological grounds.

Other topics that have been suggested, but that seem too peripheral:

Population, Technology, and the Loss of Biodiversity. E. O. Wilson

Limits of Science

M. Perutz; G. Holton;
F. Jacob

Would include a discussion of the basic differences between the natural and the social sciences -- e.g., the problem of extending science to subjective aspects of human behavior, involving value judgments; and the public misconception that the scientific method can solve any problems. Perhaps comment could be invited from a social scientist who might consider the line between natural and social sciences less sharp, and might question the traditional emphasis of scientists on strictly dissociating the search for truths about nature (including people) from their social implications.